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(54) **METHOD AND APPARATUS FOR IDENTIFYING COMMON INTEREST BETWEEN SOCIAL NETWORK USERS**

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H04L 12/58 (2006.01)
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(52) **U.S. Cl.**
CPC ***H04L 67/22*** (2013.01); ***G06F 17/30*** (2013.01); ***G06F 17/30637*** (2013.01);
(Continued)

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CPC H04L 67/22; H04L 67/306; H04L 67/30; G06F 17/30867; G06F 17/30634; G06F 17/30637; G06F 17/30646; G06F 17/30654; G06F 17/30663; G06F 17/30672; G06F 17/30693
See application file for complete search history.

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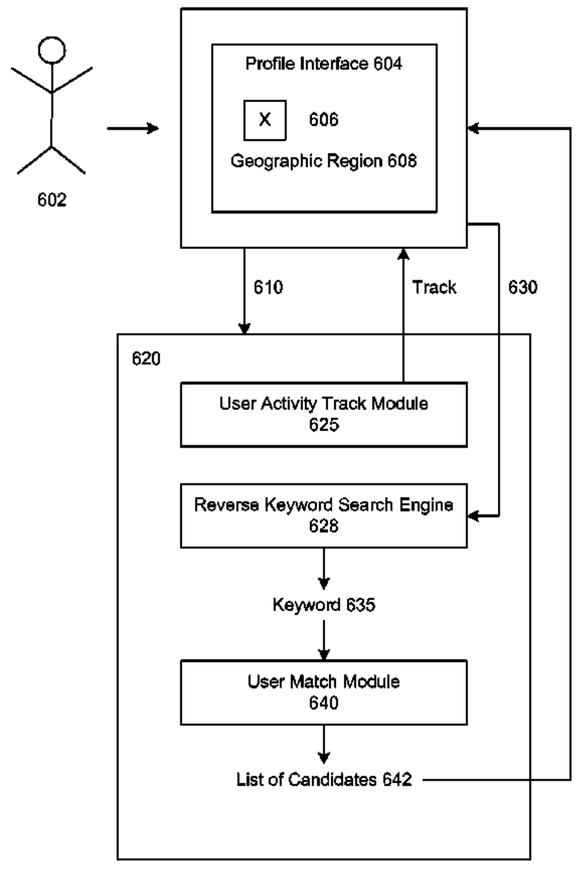
(74) *Attorney, Agent, or Firm* — Keller Jolley Preece

(57) **ABSTRACT**

Techniques for identifying mutual interests between users of a social networking system are disclosed herein. In one embodiment, a method includes steps of identifying, in a social networking system, a content object that has been interacted by a first user of the social networking system; associating, in the social networking system, a keyword with the first user, the keyword having been previously associated with the content object; and determining, in the social networking system, a mutual interest for the first user and a second user of the social networking system by identifying a match between the keyword associated with the first user with a keyword associated with the second user.

20 Claims, 9 Drawing Sheets



(51) **Int. Cl.**
G06F 17/30 (2006.01)
G06Q 50/00 (2012.01)

(52) **U.S. Cl.**
CPC .. ***G06F 17/30646*** (2013.01); ***G06F 17/30693*** (2013.01); ***G06F 17/30699*** (2013.01); ***G06F 17/30867*** (2013.01); ***G06Q 50/01*** (2013.01); ***H04L 51/32*** (2013.01); ***H04L 67/306*** (2013.01); *G06F 17/30528* (2013.01); *H04L 67/18* (2013.01)

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Notice of Allowance dated Nov. 3, 2015, for U.S. Appl. No. 13/646,618 of Naveh, B.R. et al. filed Oct. 5, 2012.

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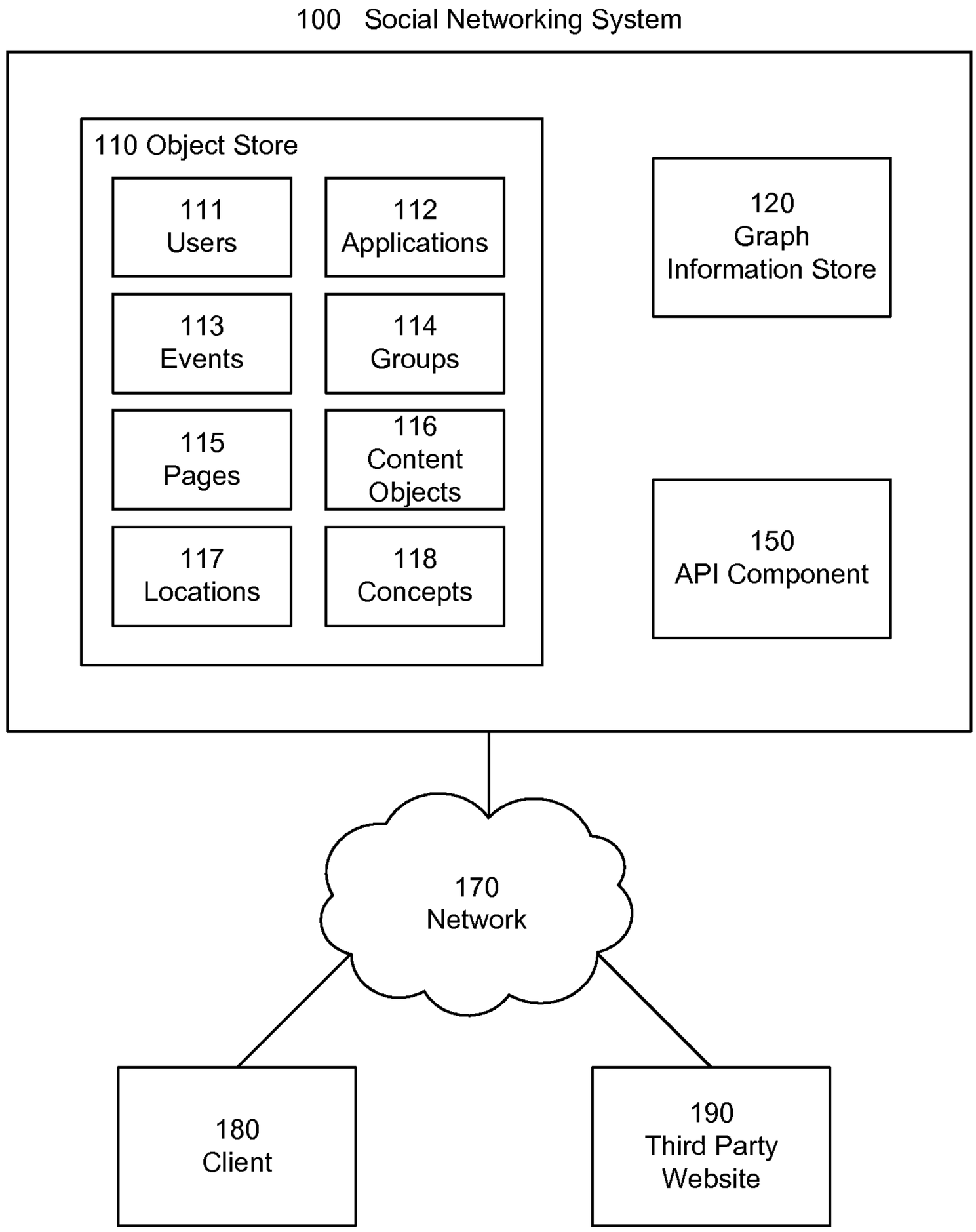
100 Social Networking System
110 Object Store
111 Users
112 Applications
113 Events
114 Groups
115 Pages
116 Content Objects
117 Locations
118 Concepts
120 Graph Information Store
150 API Component
170 Network
180 Client
190 Third Party Website

FIG. 1

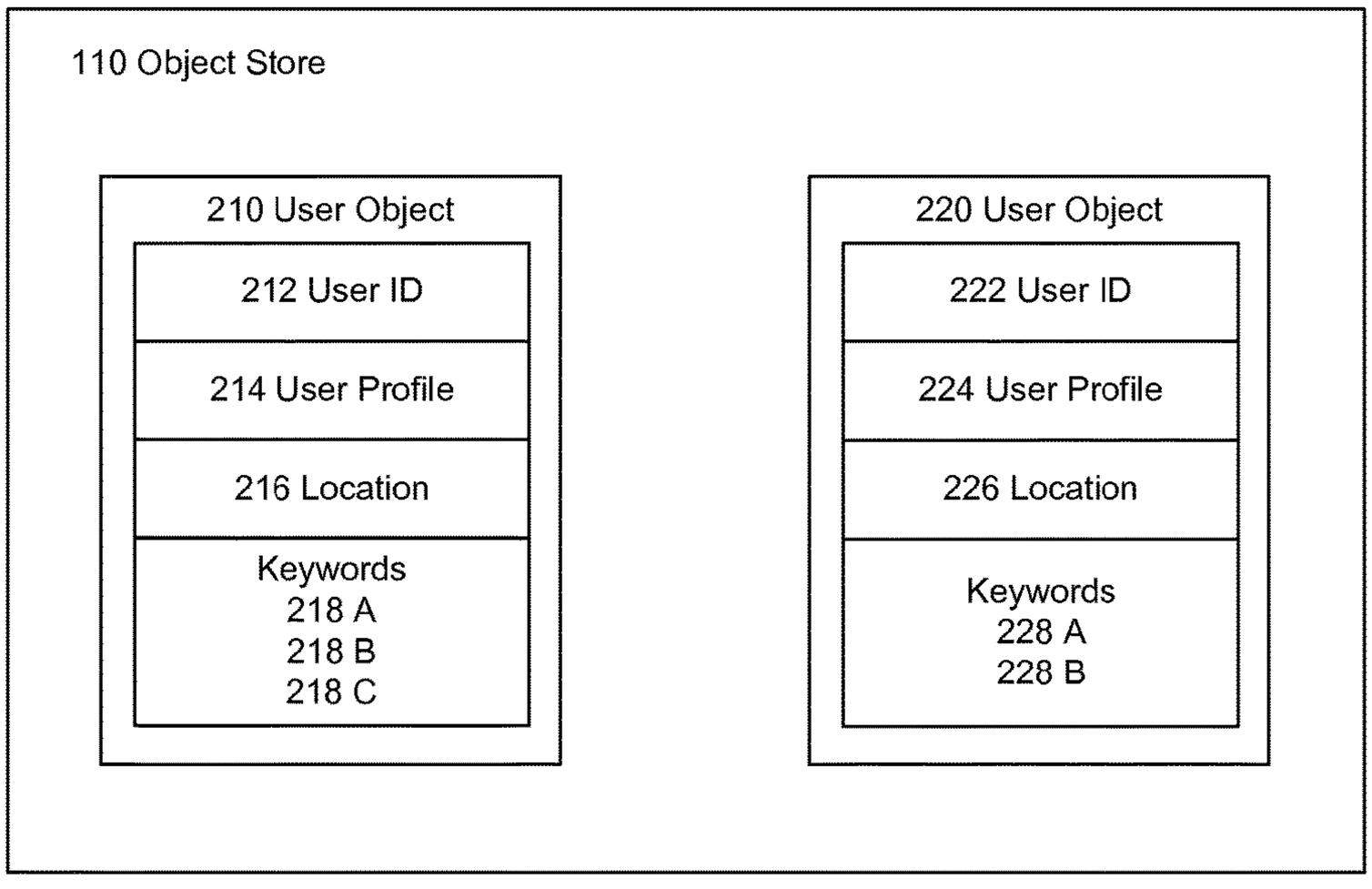
110 Object Store
210 User Object
212 User ID
214 User Profile
216 Location
Keywords
218 A
218 B
218 C
220 User Object
222 User ID
224 User Profile
226 Location
Keywords
228 A
228 B

FIG. 2

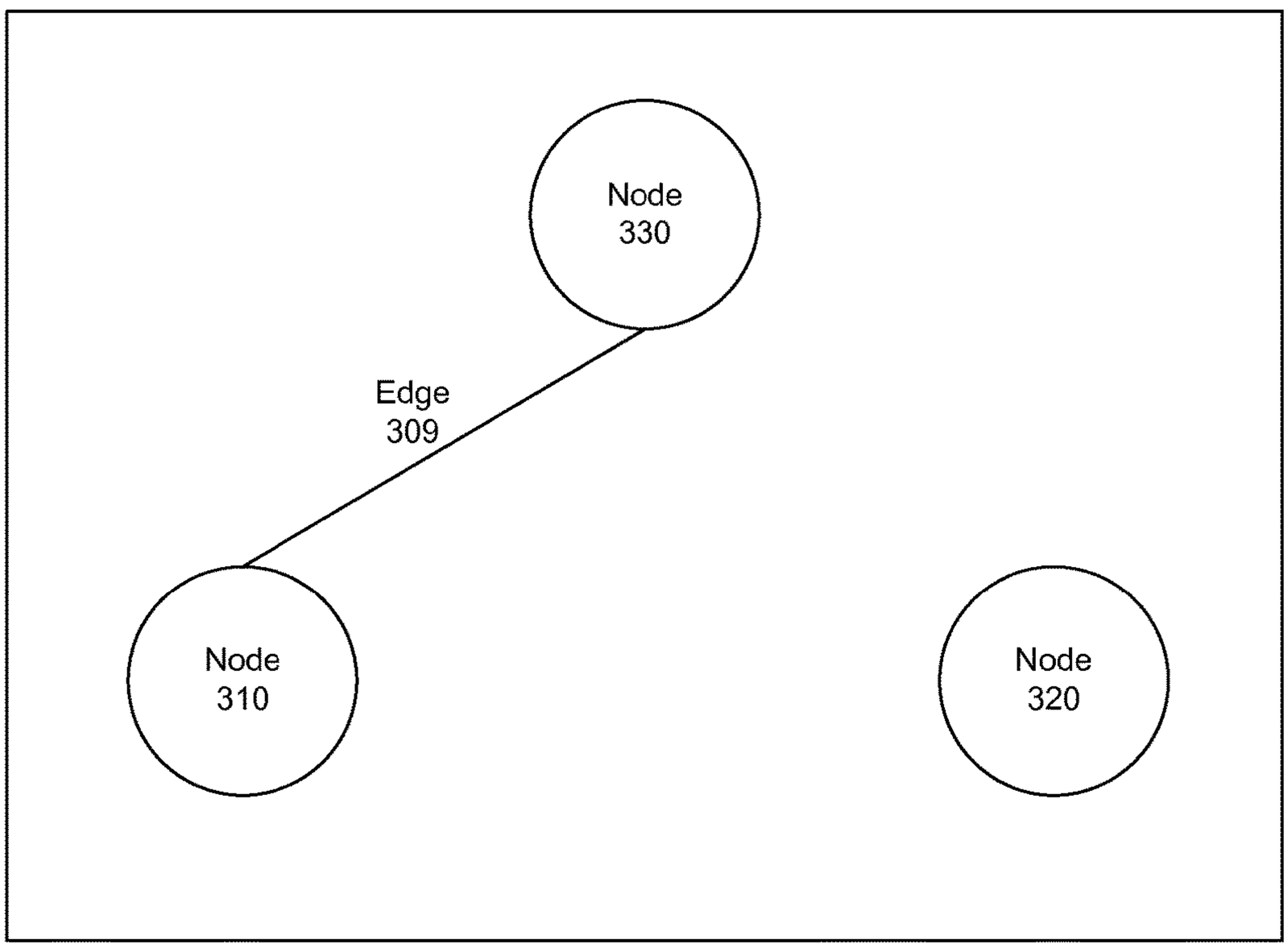
120 Graph Information Store
Node
330
Edge
309
Node
310
Node
320

FIG. 3

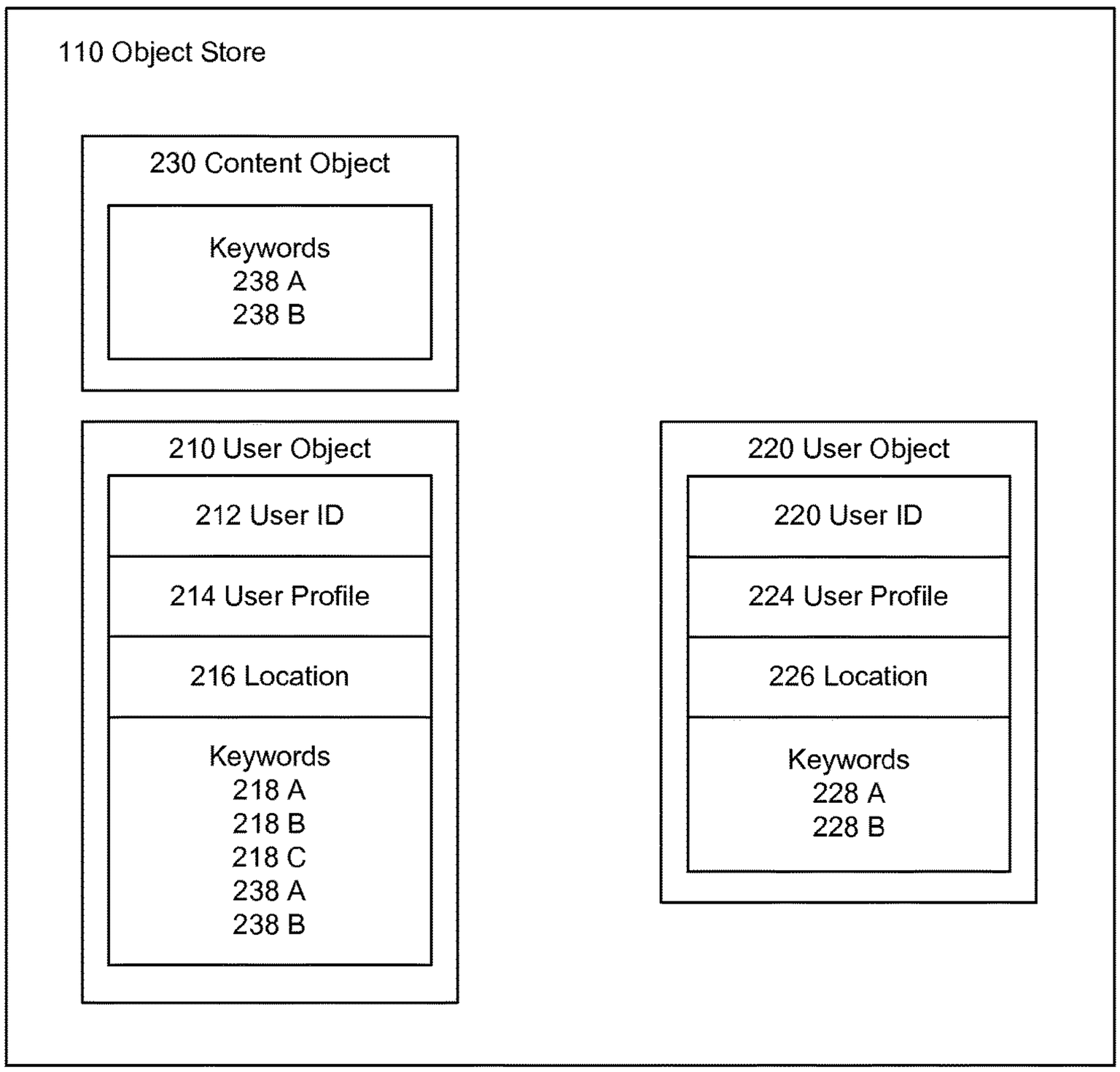
110 Object Store
230 Content Object
Keywords
238 A
238 B
210 User Object
212 User ID
214 User Profile
216 Location
Keywords
218 A
218 B
218 C
238 A
238 B
220 User Object
220 User ID
224 User Profile
226 Location
Keywords
228 A
228 B

FIG. 4

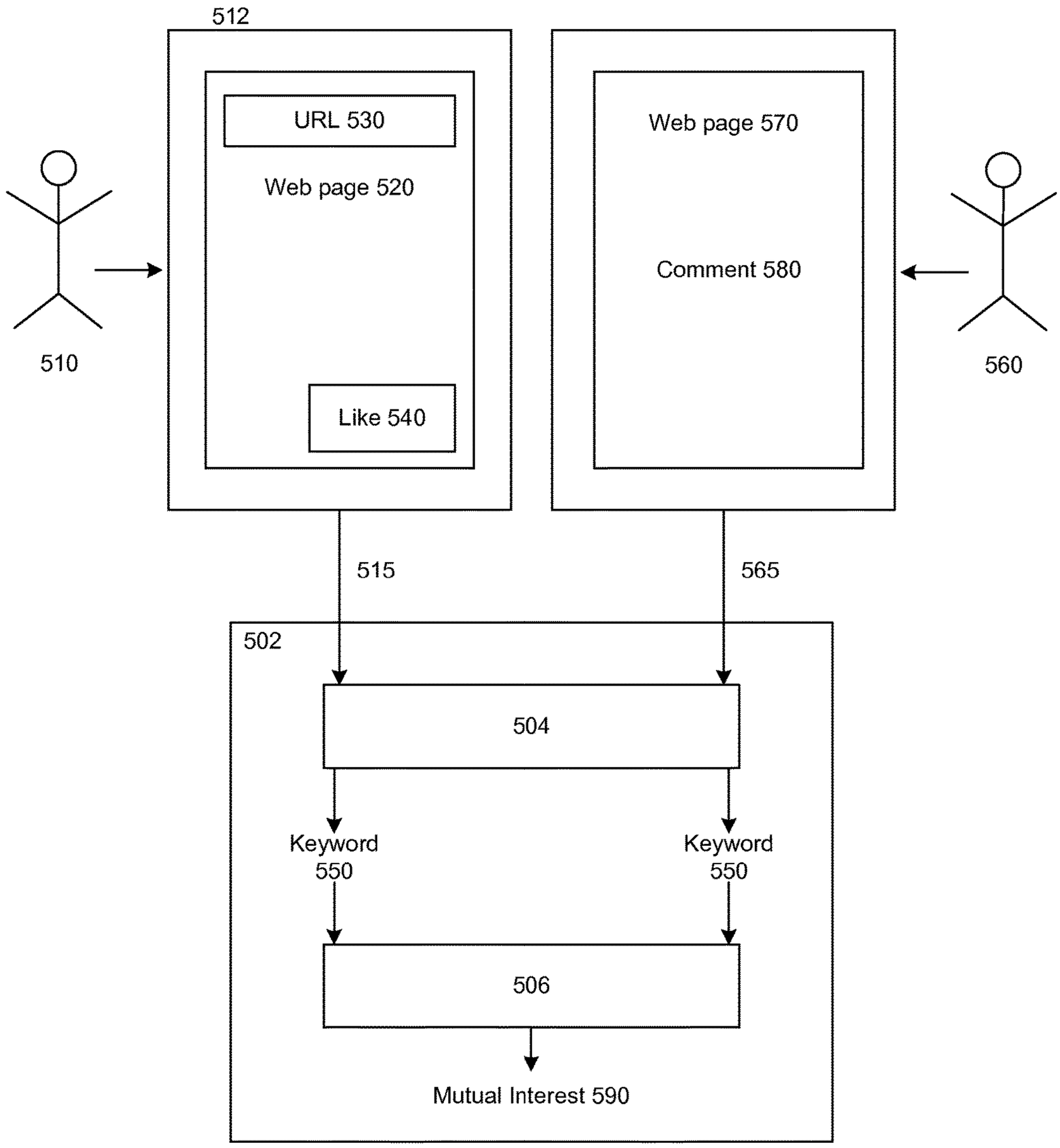
512
URL 530
Web page 520
Like 540
Web page 570
Comment 580
510
560
515
565
502
504
Keyword 550
Keyword 550
506
Mutual Interest 590

FIG. 5

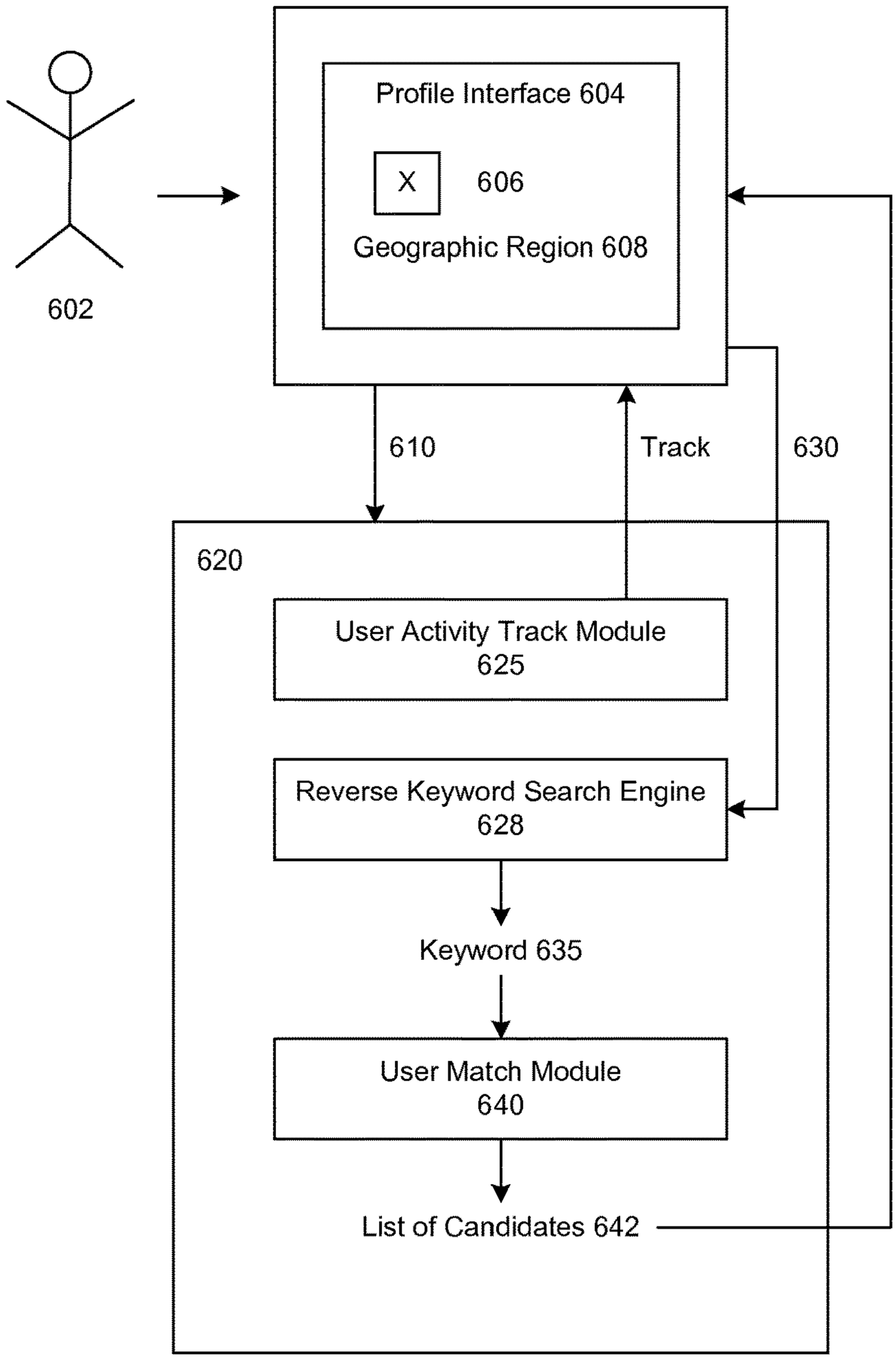
602
Profile Interface 604
X
606
Geographic Region 608
610
Track
630
620
User Activity Track Module
625
Reverse Keyword Search Engine
628
Keyword 635
User Match Module
640
List of Candidates 642

FIG. 6

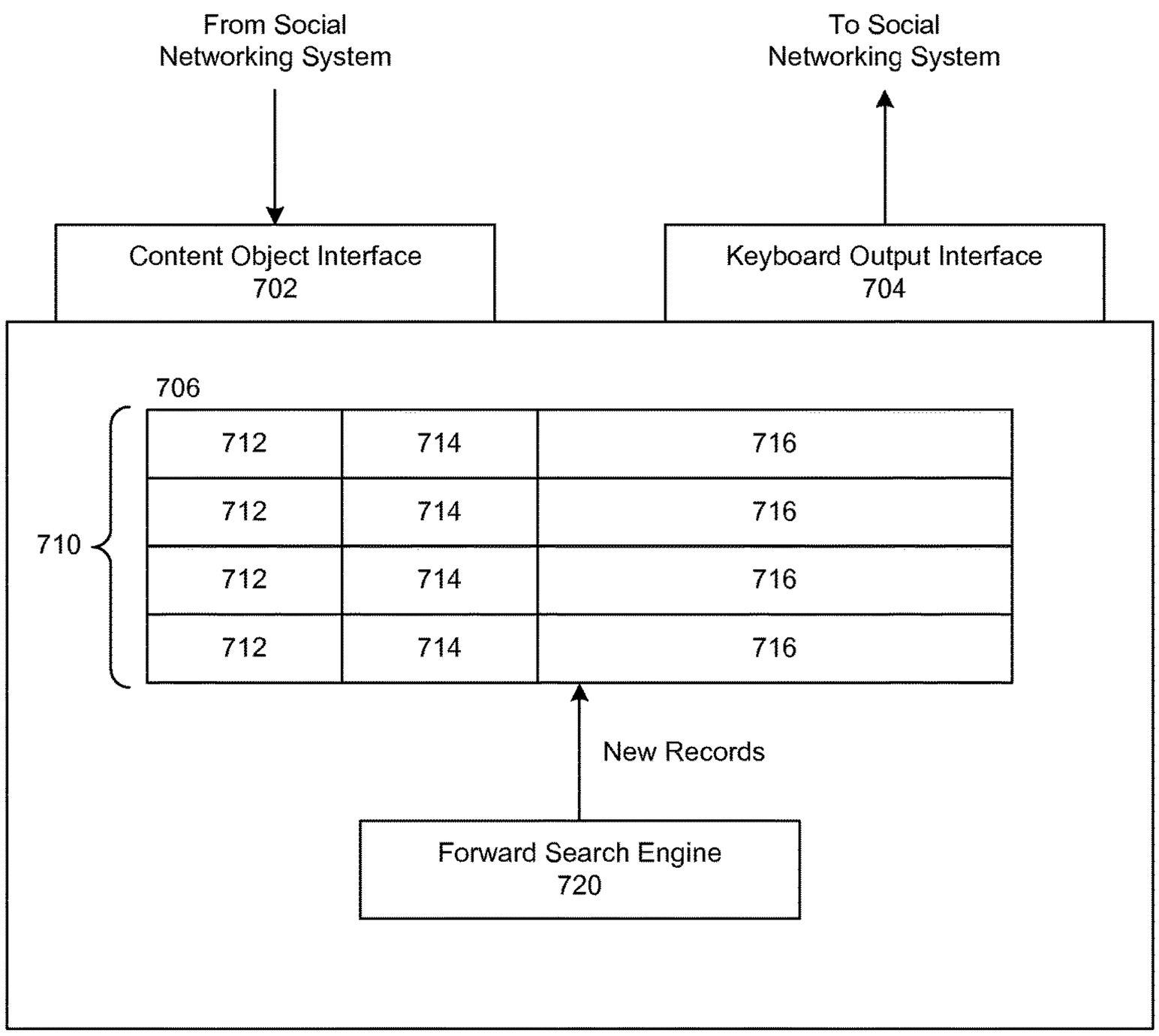
700
From Social Networking System
To Social Networking System
Content Object Interface 702
Keyboard Output Interface 704
706
710
712
714
716
New Records
Forward Search Engine 720

FIG. 7

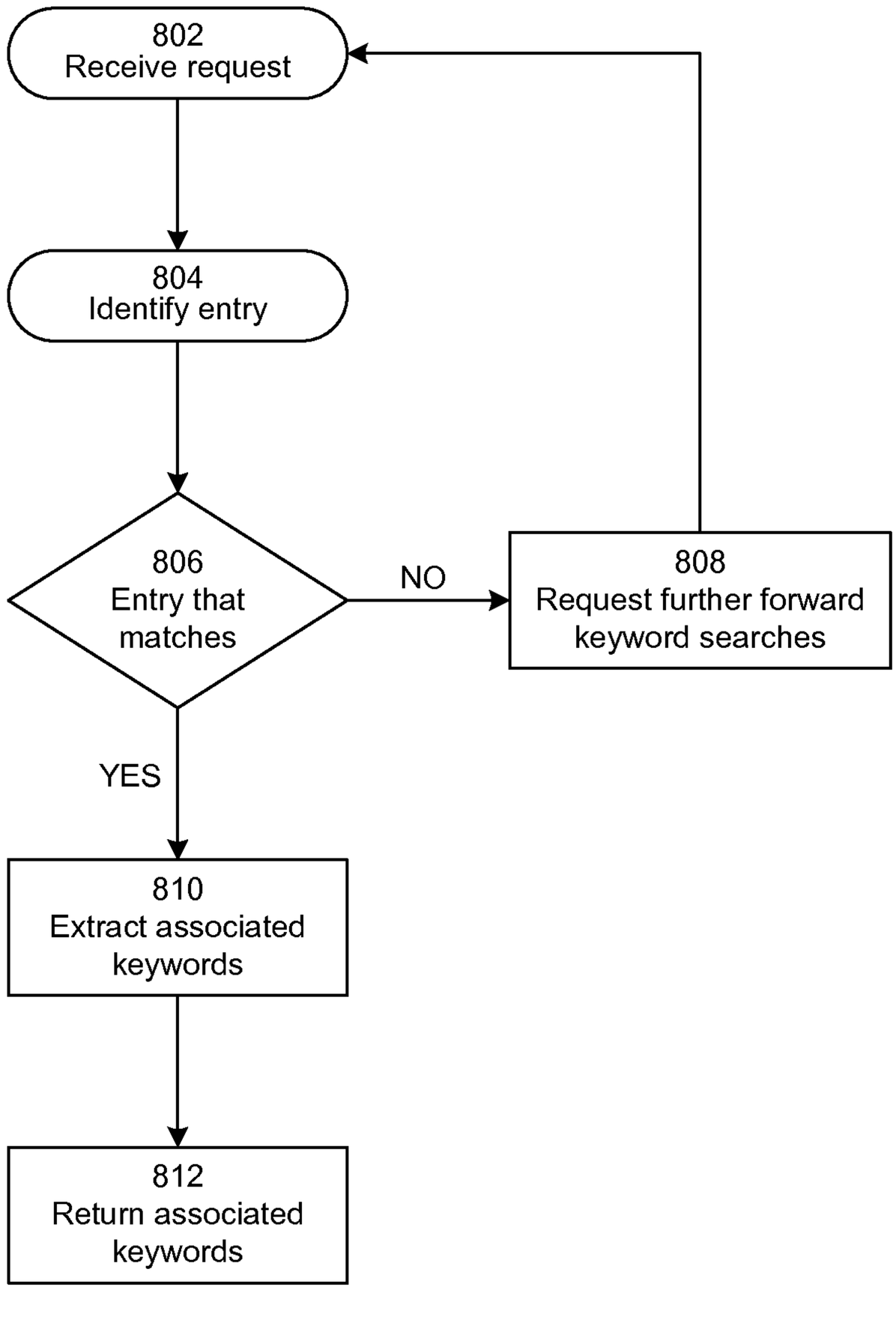
802
Receive request
804
Identify entry
806
Entry that matches
NO
808
Request further forward keyword searches
YES
810
Extract associated keywords
812
Return associated keywords

FIG. 8

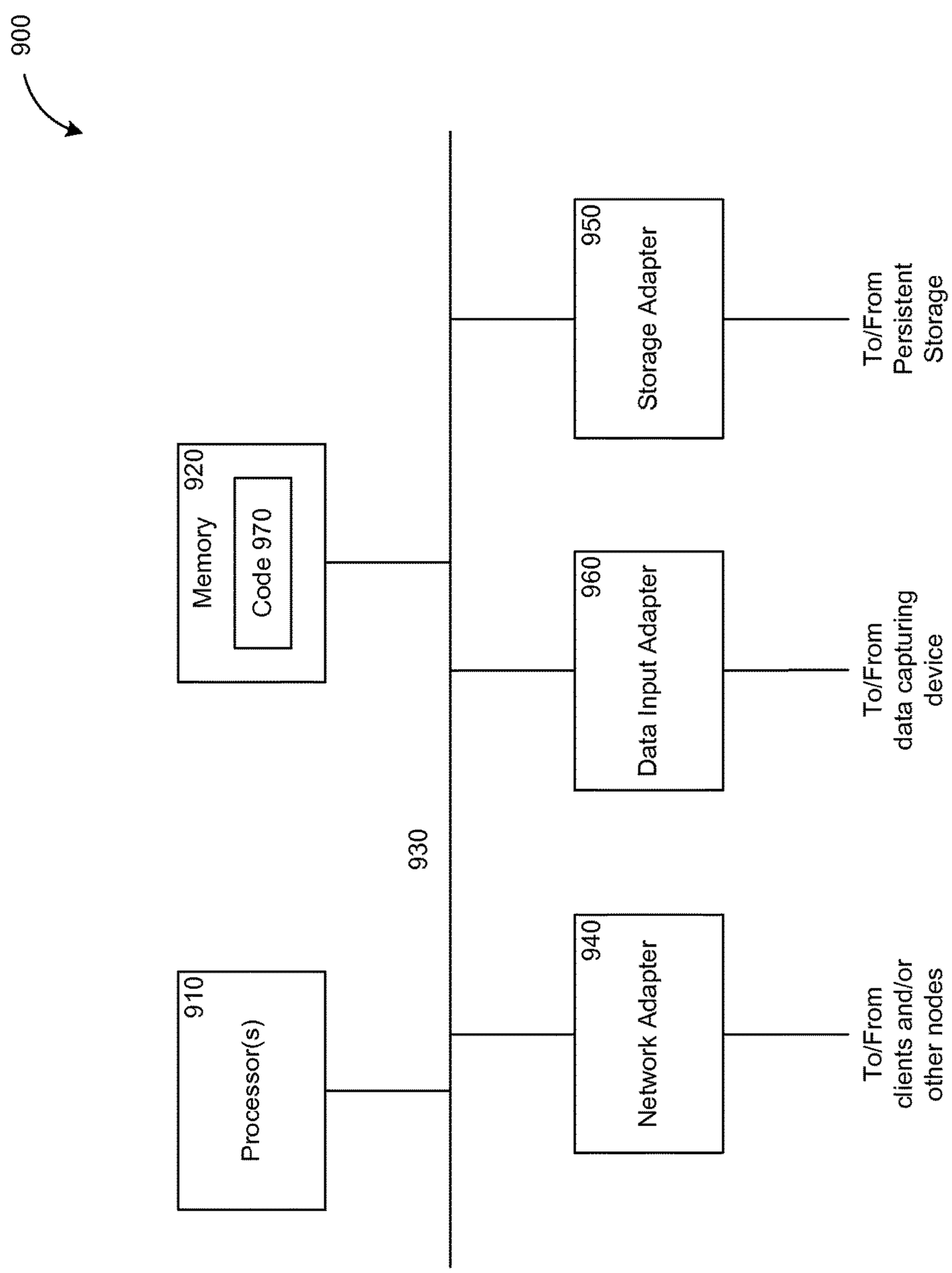
900
930
Memory 920
Code 970
Processor(s) 910
Data Input Adapter 960
To/From data capturing device
Storage Adapter 950
To/From Persistent Storage
Network Adapter 940
To/From clients and/or other nodes

FIG. 9

METHOD AND APPARATUS FOR IDENTIFYING COMMON INTEREST BETWEEN SOCIAL NETWORK USERS

CLAIM OF PRIORITY

This application is a Continuation of U.S. patent application Ser. No. 13/646,618 entitled "METHOD AND APPARATUS FOR IDENTIFYING COMMON INTEREST BETWEEN SOCIAL NETWORK USERS," filed Oct. 5, 2012, which is expressly incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates generally to social networking systems, and in particular to a social networking system capable of identifying common interests between users of the social networking system.

BACKGROUND

Social networking systems are online services, computers, platforms, or websites, or combinations thereof, which facilitate the building of social networks or social relations among people. For example, users of a social networking system can share interests, arrange activities, or even make real-life connections. An Internet-based social networking system can use representations (profiles) of the users, social links of the users, and various services to help the user to interact with and extend their social networks.

Using social networking systems, a person can grow his/her social network by discovering people who have similar interests or experiences. However, it can take a substantial amount of time and effort to identify such people. Finding unfamiliar people who share one's interests is difficult. It is not uncommon that two strangers spend a long and awkward conversation and interaction (online or face-to-face) to discover their common interests or experience.

Even with current social networking systems designed to aid the process of connecting people, the process is still primarily cumbersome and static. For example, a typical social networking website requires users to provide biographical information by filling out profile forms. A user can disclose his or her interests by providing personal information such as professional interests, career information, interests in media, political opinions and religious beliefs. A matching algorithm then uses the profile and interest data provided by the user to match other users who are determined to be like-minded by the algorithm. However, the success rate of the matching algorithm depends on the quality of the data entered by the users. For various reasons, a user may provide incomplete, inaccurate, or even misleading data that does not well represent the actual interests of the user. Further, users rarely bother to update their profile and interest data, while their interests can constantly change over time. The profile and interest data only reflects a static and potentially inaccurate image of a user at the time when the user provides the profile and interest data. Therefore, a matching algorithm such as discussed above can have a low success rate.

SUMMARY

The technology introduced here provides the benefits of automatically identifying mutual interests between social networking system users, without the need of users providing profile information describing themselves. In particular, the technology introduced here includes a method for identifying mutual interests between users of a social networking system based on keyword phrases. A keyword phrase can include one or more words, a phrase, or a sentence; and can even include symbols. The keyword phrases are generated from reverse keyword searches based on content objects in which users show interest. Content objects can include, for example, webpages, posts, messages, pictures, videos, audios, texts, any other type of media content and logical containers of the media content. Unlike conventional keyword searches (also referred to as forward keyword searches), a reverse keyword search receives a content object as input and identifies keyword phrases that are related to the content object as output. These keywords phrases are ranked by a forward keyword search as highly likely match to the content object.

In accordance with the techniques introduced here, therefore, a method for identifying mutual interests between social networking system users is provided. The method in one embodiment includes identifying, by a social networking system, a content object with which a first user of the social networking system has interacted. The social networking associates a keyword phrase with the first user.

The keyword phrase is associated with the content object. The social networking system further determines a mutual interest for the first user and a second user of the social networking system by identifying a match between the keyword phrase associated with the first user with a keyword phrase associated with the second user.

By monitoring user activities, the social networking system automatically collects keyword phrases that are related to users' interests, based on the users' interactions with content objects. The monitoring or tracking is subject to the user's privacy settings. The social networking system then identifies mutual interests among the users by comparing the keyword phrases associated with the users. There is typically no need of user interventions during the process. The system continues updating the keyword phrases based on the monitored user activities. Thus, the interests of the users are presented by the keyword phrases automatically generated by the above process truthfully and dynamically.

Other aspects of the technology introduced here will be apparent from the accompanying figures and from the detailed description, which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and characteristics of the present invention will become more apparent to those skilled in the art from a study of the following detailed description in conjunction with the appended claims and drawings, all of which form a part of this specification. In the drawings:

FIG. **1** is a high-level block diagram of a computing environment for a social networking system.

FIG. **2** illustrates an example of an object store for the social networking system.

FIG. **3** shows an example of a social graph stored in a graph information store.

FIG. **4** illustrates an example of an object store for the social networking system after a user interacting with a content object.

FIG. **5** illustrates an example scenario of identifying a mutual interest between two users of the social networking system.

FIG. **6** illustrates an example of an automatic matchmaking functionality of the social networking system.

FIG. **7** illustrates a sample reverse keyword search engine for the social networking system.

FIG. **8** illustrates steps of a sample reverse keyword search process.

FIG. **9** is a high-level block diagram showing an example of the architecture of a computer of the social networking system.

DETAILED DESCRIPTION

References in this description to "an embodiment", "one embodiment", or the like, mean that the particular feature, function, or characteristic being described is included in at least one embodiment of the present invention. Occurrences of such phrases in this description do not necessarily all refer to the same embodiment, nor are they necessarily mutually exclusive.

The social networking system disclosed herein can recognize users' interests in a dynamic and continuous manner. The social networking system monitors the user activities to identify content objects in which the users show interests via interactions. The monitoring is subject to the user's privacy settings. Through reverse keyword searches based on the identified content objects, the system generates keyword phrases to truthfully represent the users' interests. Therefore, the social networking system can make targeted matches between the users by comparing the updated keyword phrases accurately representing the users' current interests. The social networking system can include one or more computers and/or other processing devices.

FIG. **1** is a high-level block diagram of a computing environment for such a social networking system **100**. One or more client devices **180** (also referred to as "clients") and one or more third party websites **190** are connected with the social networking system **100** by a network **170**. The network **170** can be, for example, the Internet, a metropolitan area network (MAN), a wide area network (WAN), a LAN, or any other type of network or combination of networks. The client device **180** may be, for example, a conventional personal computer (PC), server-class computer, workstation, handheld computing/communication device (e.g., a smartphone), or the like. A user of the client device **180** interacts with the social networking system **100** via an application (e.g. a web browser application) that runs on the client device **180**. Via the application, the user of the client device **180** can perform various tasks on the social networking system **100** including browsing content, posting comments, submitting messages, performing queries for people or content objects, and the like.

The social networking system **100** can further include components to exchange information with the third party website **190**, such as the application programming interface (API) component **150**. The third party website **190** can interact with the social networking system **100** via an API component **150** which is provided by the social networking system **100**. For instance, the third party website **190** can perform operations supported by the API, including performing queries to obtain information stored in the social networking system **100**, and providing results based on requests from the social networking system **100**.

As shown in FIG. **1**, the social networking system **100** includes a number of components to store information of objects represented in the social networking system **100**, as well as the relationships between the objects. The social networking system **100** further includes components to enable clients interactively using the social networking system **100**.

The social networking system **100** includes an object store **100** that stores information of various objects tracked by the social networking system **100**. The tracking is subject to the user's privacy settings. These objects can present a variety of things with which a user may interact in the social networking system **100**. The objects may include profiles of the users **111**, applications **112**, events **113**, groups **114** to which users may belong, pages **115**, content objects **116** such as pictures, videos, audios, texts or any other type of media content, locations **117** associated with users or other objects, and concepts **118**.

In one embodiment, the object store **110** can further store content objects representing data produced by users of the social networking system **100**, such as inbox messages, status updates, photos, videos, comments, notes and postings. An object in the object store **110** can represent an entity existing with the social networking system **100** (e.g. an application **112** running on the social networking system), a virtual entity that exists outside the domain of the social networking system (e.g. a website), or a real-world entity (e.g. a retail store or a sports team).

The object store **100** can store all objects within the social networking system **100**. Alternatively, for virtual entities outside of the social networking system **100**, the object store **110** can include pointers or references to the virtual entities, such as the uniform resource locator (URL) of a media file or a webpage stored in a third party website. In addition, the object store **110** can also store metadata associated with the objects, such as names describing the objects, images representing the objects (e.g. user profile pictures), or one or more keyword phrases (e.g. implemented as tags) associated with the objects. A keyword phrase can contain one or more words. Different types of objects can have different types of metadata. For example, a user object **111** can have unique ID, a name, and keyword phrases describing characteristics of the user object **111**. A content object **116** can have a media type metadata, a thumbnail image, and keyword phrases describing the content of the content object **116**. An object in the object store **100** can contain information as a pointer or a reference to another object. For example, a user object can contain a pointer to a location object to indicate that the user's current location.

In one embodiment, the social networking system **100** further includes a graph information store **120** that stores information for a social graph of the social networking system **100**. The social graph contains nodes representing the objects stored in the object store **110**. The social graph further contains edges connecting the nodes to represent the relationships between the objects. The graph information store **120** thus includes information of the relationships between the objects, represented as the edges connecting the nodes.

The social graph can include different types of edges representing different relationships between objects. Various examples of edges in the social graph include: an edge between two user objects representing that the users have a relationship in the social networking system (e.g., are friends, or have communicated, viewed the other's profile, or interacted in some way); an edge between a user object and an application object representing that the user has used the application; an edge between a user object and a group object representing that the user belongs to the group; and an edge between a user object and a page object representing that the user has viewed the page, to name just a few.

In one embodiment, if one user establishes a relationship with another user in the social networking system, the two users are each represented as a node, and the edge between

them represents the established relationship. The two users are then connected in the social network system. Continuing this example, one of these users may send a message to the other user within the social networking system. This act of sending the message is another edge between those two nodes, which can be stored and/or tracked by the social networking system. The tracking is subject to the user's privacy settings. In one embodiment, the message itself can be treated as a node (i.e. an object in the social networking system).

In another embodiment, one user may post a comment on an image that is maintained or monitored by the social networking system. This commenting interaction can create edges among the nodes representing the user, the image and the posted comment. In yet another embodiment, if a user confirms attending an event, wherein the user and the event are nodes, an edge between these two nodes represents the indication of whether or not the user will attend the event. Using a social graph, therefore, a social networking system may keep track of many different types of objects and edges (the interactions and connections among those objects), thereby maintaining an extremely rich store of socially relevant information. The monitoring and tracking are subject to the user's privacy settings.

In one embodiment, edges in the graph information store **120** can also have associated metadata, such as a label describing the type of relationship (e.g., "friend" as the label between two user objects), or a value quantifying the strength of the relationship. Further, a relationship degree, or "distance," between any two objects can be ascertained by determining the number of edges on the shortest path between the objects. For example, two user objects that have an edge between them (e.g., denoting a friendship relationship) have a relationship degree (or "distance") of one and are considered first-order connections. Similarly, if a user object A is a first-order connection of user object B but not of user object C, and B is a first-order connection of C, then objects A and C have a relationship degree of two, indicating that C is a second-order connection of A (and vice-versa).

In one embodiment, the social networking system **100** adds or updates information to the graph information store **120** in real time as it observes events taking place indicating relationships between the various objects, such as a user **111** interacting with an application **112**. Additionally, the graph information store **120** can contain edges that are based on existing stored information from which relationships can be inferred. For example, data for a group **114** may indicate that some set of users has a membership relationship with that group, and this information can be reflected in the graph information store **120**.

In one embodiment, the object store **110** of the social network system **100** stores information on the objects including the keyword phrases associated with the objects. FIG. **2** illustrates an example of an object store for the social networking system. The object store **110** includes a user object **210** representing a user of the social networking system and another user object **220** representing another user. The user object **210** can include metadata such as a user ID **212**, a user profile **214**, a location **216** and keyword phrases (**218**A, **218**B and **218**C) associated with the user object **210**. Similarly, the user object **220** can include metadata such as a user ID **222**, a user profile **224**, a location **226** and keyword phrases (**228**A and **228**B) associated with the user object **220**. As shown in FIG. **1**, the object store **110** can include other objects besides the user objects **210** and **220**.

A user object can interact with other objects within the social network system **100**, including other user objects and content objects. The social network system **100** identifies the interaction and adds edges into the social graph stored in the graph information store **120** (shown in FIG. **1**) to represent the relationship between the user object and the object with which the user object interacts. For example, FIG. **3** shows an example of a social graph stored in a graph information store. Node **310** is a node in the social graph that represents the user object **210** of FIG. **2**. Node **320** is a node in the social graph that represents the user object **220** of FIG. **2**. Node **330** is a node in the social graph that represents a content object. In some embodiments, the node **330** can represents a content object such as an image, a video, an audio, a text, a post, a webpage, or a URL.

A user represented by the node **310** (also referred to as "user **310**") interacts with the content object represented by the node **330** (also referred to as "content object **330**"). For example, the user **310** may click to view a webpage **330**. Or the user **310** may comment on an image **330**. Or the user **310** may click a Like button of a video **330** to indicate that the user **310** likes the video **330**. The social networking system detects the interaction between the user **310** and the content object **330**. Accordingly, the graph information store **120** adds an edge **309** between the node **310** and node **330** to represent the interaction relationship between the nodes.

In one embodiment, the social networking system looks for an object in the object store **110** that is represented by the node **330**. FIG. **4** illustrates an example of the object store that includes the content object **230** that is represented by the node **330** of FIG. **2**. The content object **230** includes a number of keyword phrases **238**A and **238**B. In one embodiment, the content object **230** is a webpage; and the keyword phrases **238**A and **238**B are the keyword phrases associated with the webpage.

In another embodiment, the social networking system looks for an object in the object store **110** that is represented by the node **330** and finds no such object. The social networking system creates an object **230** to be represented by the node **330**.

Then the social networking system conducts a reverse keyword search on the content object. For example, the content object is a webpage; and the social networking system conducts reverse keyword search based on a URL of the webpage. If there is any keyword phrase returned from the reverse keyword search, the social networking system includes the returned keyword phrase into the object **330** of the object store **110**. In yet another embodiment, the social networking system finds existing keyword phrases associated with the object **330**. And the social networking system still conducts a reverse keyword search for an update of the keyword phrases. If there is any difference between the keyword phrases returned and the existing keyword phrases, the social networking system updates the object **330** to reflect the latest search result of the reverse keyword search.

Once the social networking system identifies the content object **330** and its associated keyword phrases **238**A and **238**B, the social networking system associates the keyword phrases **238**A and **238**B to the user object **210** based on the interaction represented by the edge **309** of FIG. **3**. After the associating, the user object **210** includes keyword phrases **218**A, **218**B, **218**C, as well as **238**A and **238**B, as shown in FIG. **4**.

The social networking system compares the keyword phrases included in the user object **210** with keyword phrases included in another user object, such as user object **220**. In one embodiment, the social networking system

identifies a match between the keyword phrase **238**B in the user object **210** with the keyword phrase **228**B in the user object **220**. Based on the match between the keyword phrases **238**B and **228**B, the social networking system determines a mutual interest that is suggested by the keyword phrases **238**B and **228**B for the users identified by the user objects **210** and **220**.

In one embodiment, the social networking system can identify multiple matches between keyword phrases associated with two users of the social networking system. The match is not necessarily a one-to-one keyword phrase match. There can be a match between one keyword phrase associated with one user and multiple keyword phrases associated with another user. Or there can be a match between multiple keyword phrases associated with one user and multiple keyword phrases associated with another user. In another embodiment, there can be multiple matches between keyword phrases associated with one user and keyword phrases associated with another user. The social networking system determines multiple mutual interests based on the keyword phrase matches.

In one embodiment, the social networking system identifies a match when a keyword phrase associated with one user is identical to a keyword phrase associated with another user. In another embodiment, the social networking system identifies a match when a keyword phrase associated with one user is closely related to a keyword phrase associated with another user. In yet another embodiment, the social networking system identifies a match when a keyword phrase associated with one user is a synonym or an antonym of a keyword phrase associated with another user.

The social networking system monitors and analyzes the user activities to collect keyword phrases that represent interests of the users. The system compares the keyword phrases to identify mutual interests between the users. FIG. **5** illustrates a scenario of identifying a mutual interest between two users of a social networking system. A user **510** of a social networking system reads a webpage **520** identified by a URL **530** of the webpage **520**. The webpage **520** can be rendered by a browser program running a computer or a smart phone **512**. The user **510** clicks a Like button **540** placed in the webpage **520** to indicate that the user **510** likes the content of the webpage **520**. Accordingly, the browser sends a message **515** about the user **510**'s action to the social networking system **502**. In one embodiment, the message **515** can include URL **530** as an identification of the webpage **520**. In some embodiments, the social networking system **502** can include a user activity track module **508** (not shown) dedicated to monitor and detect users' interaction with content objects. The monitoring and tracking are subject to the user's privacy settings.

In another embodiment, a user of a social networking system interacts with a content object rendered in an application running on a user device (e.g. a mobile device or a computer). The user device monitors the user activities related to the application. Once a user activity indicating that the user is interested in the content object is recognized, the user device sends a message about the user's action to the social networking system, in a similar manner as described in the previous paragraph. For instance, the user activity can be that the user has been clicking the content object for more than a predetermined time period.

The social networking system **502** conducts a reverse keyword search on the webpage **520**. In one embodiment, the reverse keyword search is conducted by a reverse keyword search engine **504** inside the social networking system **502**. In another embodiment, the reverse keyword search was conducted on a third party server or cluster as a third party service.

The social networking system can receive one or more keyword phrases associated with the webpage **520** as a result of the reverse keywords search. In the context of the description herein, a keyword phrase can include one or more words, a phrase, or a sentence; and can even include symbols. For example, the social networking system identifies a keyword phrase **550** "colonization of mars" from the reverse keyword search on the webpage **520**. Based on the interaction between the user **510** and the webpage **520**, the social networking system associates the keyword phrase **550** "colonization of mars" to the user **510** to suggest that the user **510** is interested in the topic of "colonization of mars."

Similarly, using a browser program, another user **560** of the social networking system posts a comment **580** on the social networking system citing a webpage **570**. Accordingly, the browser program sends a message **565** about the user **560**'s action to the social networking system. In one embodiment, the message **565** can also include a URL of the webpage **570** as identification of the content object. The social networking system conducts another reverse keyword search on the webpage **570**. The social networking system identifies the same keyword phrase **550** "colonization of mars," as a result of the reverse keyword search. Based on the interaction between the user **560** and the webpage **570**, the social networking system associates the same keyword phrase **550** "colonization of mars" to the user **560** to suggest that the user **560** is also interested in the topic of "colonization of mars."

The social networking system **502** compares the keyword phrases associated with the user **510** with the keyword phrases associated with the user **560**. In one embodiment, the social networking system **502** includes a user match module **506** to identify a keyword phrase match that both the users **510** and **560** are associated with the keyword phrase **550**. Suggested by the shared keyword phrase **550**, the user match module **506** determines a mutual interest **590** for "colonization of mars" for both users **510** and **560** of the social networking system **502**.

In one embodiment, the social networking system can have a feature to introduce or recommend users who share one or more interests (e.g. a "People You Should Meet" feature). For example, the social networking system can send a private system message to a user indicating that another user shares a common interest with him/her. Or, the social networking system identifies that users A and B share a common interest, and sends a notice to user A suggesting that user A attend an event because user B also plans to attend the event.

The social networking system can conduct the matchmaking functionality without users' intervention. FIG. **6** illustrates an example of the automatic matchmaking functionality of the social networking system. A user **602** of the social networking system **620** can set up the user profile of the user **602** to instruct the social networking system **620** that the user **602** wants to opt-in to the automatic matchmaking functionality. For example, the user **602** can click an opt-in checkbox **606** in a user profile interface webpage **604** for the automatic matchmaking functionality. The user **602** can further identify the geographic region **608** in the user profile on which the matchmaking functionality should focus. In another embodiment, the social networking system **620** can automatically identify the geographic region based on the user profile and user activity history without inter-

vention from the user **602**. The choice that the user **602** made is sent to the social networking system **620** as an instruction **610**.

Upon receiving the instruction **610**, the social networking system **620** starts to track the user activities of the user **602** including the user's interactions with content objects such as pictures, videos, audios, texts or any other type of media content. There are various user interactions being tracked by the social networking system. For example, the user can click and read a webpage, post a comment to a posted message, or click a Like button to express the appreciation of an online article. In one embodiment, the social networking system **620** includes a user activity track module **625** dedicated to monitoring and detecting the users' interaction with content objects. The monitoring and tracking are subject to the user's privacy settings.

Each time the social networking system **620** detects a content object with which the user has interactions, the social networking system conducts a reverse keyword search in its reverse keyword search engine **628** based on the interacted content object **630**. The social networking system may receive one or more keyword phrases **635** associated with the content object **630**. If the social networking system receives any keyword phrase **635**, the system associates the keyword phrase with the user **602**.

Periodically, the social networking system **620** uses a user match module **640** to search candidates who have keyword phrases matched with the keyword phrases associated with user **602**, among users located in the target geographic region. The search result varies over time since keyword phrases associated with users constantly evolve and increase. In one embodiment, the social networking system provides the user **602** with a list of candidates **642**. The list of candidates **642** is accompanied by the matched keyword phrases and certain profile information of the candidates. The social networking system can further provide links to communicate with the candidates. For example, the user **602** may click one entry of the list of candidates to access a user interface to provide and send a system message to a candidate. In some embodiments, the system initially conceals the identities of the candidates from the user **602** to protect user privacy. The system may later reveal the identity of a candidate once the candidate confirms the reveal request or the candidate starts to interact with the user **602**. During the automatic matching process, the user **602** does not need to specify any characteristics of potential matching candidates.

The social networking system automatically tracks and analyzes the user **602**'s activities to assess the interests of the user **602**. The tracking is subject to the user's privacy settings. Based on the information from the automatic tracking, the social networking system is able to present matching candidates to the user **602** periodically. In one embodiment, the user **602** can choose the frequency for receiving matching candidate suggestions. In another embodiment, the social networking system automatically determines the frequency based on the user activities of the user **602** and how often the keyword phrases associated with the user **602** are updated.

The social networking system can include a reverse keyword search engine to generate keyword phrases based on the inputs of content objects. FIG. **7** illustrates a sample reverse keyword search engine. In one embodiment, the reverse keyword search engine is part of the social networking system. In another embodiment, the reverse keyword search engine works as a third party server outside of the social networking system. As shown in FIG. **7**, the reverse keyword search engine **700** includes a content object interface **702**. The content object interface is configured to receive content objects or the identifications (e.g. URLs) of the content objects from the social networking system. The reverse keyword search engine **700** further includes a keyword output interface **704**. Once the reverse keyword search engine **700** generates the keyword phrases associated with the received content object, the keyword output interface **704** sends the associated keyword phrases to the social networking system.

The reverse keyword search engine **700** also includes a search pattern database **706** to record the relationships between the content objects and the keyword phrases. As shown in FIG. **7**, the search pattern database **706** contains a plurality of records **710**. Each record **710** includes an identifier **712** of a content object and a keyword phrase **714** associated with the content object. There can be multiple records having the same identifier **712** and different keyword phrases **714**. Similarly, there can be multiple records having the same keyword phrases **714** and different identifier **712**. The record **710** can further include metadata **716**. In one embodiment, the metadata can include a rank of the content object in a forward search result using the keyword phrase. A forward search is a conventional web search process that takes keyword phrases as input and outputs a list of related web pages or contents.

The reverse keyword search engine **700** generates the records **710** by conducting multiple forward searches using a forward search engine **720**. In one embodiment, for each forward search using a keyword phrase, the first N number of search results (i.e. content objects) are considered to be associated with the keyword phrase, N being a predetermined number. Accordingly the first N number of content objects are recorded along with the associated keyword phrase in the search pattern database **706**. In one embodiment, the forward search engine **720** is built-in as part of the reverse keyword search engine **700**, as illustrated in FIG. **7**. In another embodiment, the forward search engine **720** can be a separate server outside of the reverse keyword search engine **700**.

FIG. **8** illustrates a sample reverse keyword search process. For instance, the reverse keyword search engine **700** as shown in FIG. **7** can conduct the sample reverse keyword search process as illustrated in FIG. **8**. At step **802**, a reverse keyword search engine receives a request to conduct a reverse keyword search on a content object. The request can include an identifier of the content object or the content object itself. For instance, the content object can be a webpage and the identifier can be a URL of the webpage. At step **804**, the reverse keyword search engine identifies entries in its search pattern database to check whether there are any entries that matches the content object (**806**). The reverse keyword search engine collects the entries in the search pattern database by conducting continuous or periodic forward keyword searches. If there is no entry in the search pattern database that matches the content object, the reverse keyword search engine may request further forward keyword searches (**808**). If there is an entry identified as matching the content object, at step **810**, the reverse keyword search engine extracts the associated keyword phrases from the identified entries from the search pattern database. At step **812**, the reverse keyword search engine returns the associated keyword phrases as the result of the reverse keyword search request.

FIG. **9** is a high-level block diagram showing an example of the architecture of a computer of the social networking system, which may represent any server or host computer hosting the user activity track module, the reverse keyword

search engine, the object store, the graph information store, the user match module, the search pattern database, the forward search engine, or other components of the social networking system described herein. The computer **900** includes one or more processors **910** and memory **920** coupled to an interconnect **930**. The interconnect **930** shown in FIG. **9** is an abstraction that represents any one or more separate physical buses, point to point connections, or both connected by appropriate bridges, adapters, or controllers. The interconnect **930**, therefore, may include, for example, a system bus, a Peripheral Component Interconnect (PCI) bus or PCI-Express bus, a HyperTransport or industry standard architecture (ISA) bus, a small computer system interface (SCSI) bus, a universal serial bus (USB), IIC (I2C) bus, or an Institute of Electrical and Electronics Engineers (IEEE) standard 1394 bus, also called "Firewire".

The processor(s) **910** is/are the central processing unit (CPU) of the storage controller **900** and, thus, control the overall operation of the computer **900**. In certain embodiments, the processor(s) **910** accomplish this by executing software or firmware stored in memory **920**. The processor(s) **910** may be, or may include, one or more programmable general-purpose or special-purpose microprocessors, digital signal processors (DSPs), programmable controllers, application specific integrated circuits (ASICs), programmable logic devices (PLDs), trusted platform modules (TPMs), or the like, or a combination of such devices.

The memory **920** is or includes the main memory of the computer **900**. The memory **920** represents any form of random access memory (RAM), read-only memory (ROM), flash memory, or the like, or a combination of such devices. In use, the memory **920** may contain a code **970**. In one embodiment, the code **970** includes a user activity track module, a reverse keyword search engine, a user match module, or a forward search engine described herein.

Also connected to the processor(s) **910** through the interconnect **930** are a network adapter **940** and a storage adapter **950**. The network adapter **940** provides the computer **900** with the ability to communicate with remote devices, over a network and may be, for example, an Ethernet adapter or Fibre Channel adapter. The network adapter **940** may also provide the computer **900** with the ability to communicate with other computers within the social networking system. In some embodiments, a computer may use more than one network adapter to deal with the communications within and outside of the system separately. The storage adapter **950** allows the computer **900** to access a persistent storage, and may be, for example, a Fibre Channel adapter or SCSI adapter.

The code **970** stored in memory **920** may be implemented as software and/or firmware to program the processor(s) **910** to carry out actions described above. In certain embodiments, such software or firmware may be initially provided to the computer **900** by downloading it from a remote system through the computer **900** (e.g., via network adapter **940**).

The techniques introduced herein can be implemented by, for example, programmable circuitry (e.g., one or more microprocessors) programmed with software and/or firmware, or entirely in special-purpose hardwired circuitry, or in a combination of such forms. Special-purpose hardwired circuitry may be in the form of, for example, one or more application-specific integrated circuits (ASICs), programmable logic devices (PLDs), or field-programmable gate arrays (FPGAs), etc.

Software or firmware for use in implementing the techniques introduced here may be stored on a machine-readable storage medium and may be executed by one or more general-purpose or special-purpose programmable microprocessors. A "machine-readable storage medium", as the term is used herein, includes any mechanism that can store information in a form accessible by a machine (a machine may be, for example, a computer, network device, cellular phone, personal digital assistant (PDA), manufacturing tool, any device with one or more processors, etc.). For example, a machine-accessible storage medium includes recordable/non-recordable media (e.g., read-only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; etc.), etc.

The term "logic", as used herein, can include, for example, programmable circuitry programmed with specific software and/or firmware, special-purpose hardwired circuitry, or a combination thereof.

In addition to the above mentioned examples, various other modifications and alterations of the invention may be made without departing from the invention. Accordingly, the above disclosure is not to be considered as limiting and the appended claims are to be interpreted as encompassing the true spirit and the entire scope of the invention.

We claim:

1. A method, comprising:

identifying, by a social networking system, a first content object with which a first user of the social networking system has interacted at a previous time period;

conducting a reverse keyword search on the first content object to identify a first keyword phrase associated with the first content object by:

performing a plurality of forward keyword searches until the first content object is identified in search results of a forward keyword search of the plurality of forward keyword searches; and

generating the first keyword phrase for the first content object utilizing a keyword phrase of the forward keyword search that identified the search results having the first content object;

associating, by the social networking system, the first keyword phrase with the first user;

identifying a match between the first keyword phrase associated with the first user and a second keyword phrase associated with a second user of the social networking system; and

determining, by the social networking system and based on the match, a common interest for the first user and the second user that is represented by the first keyword phrase and the second keyword phrase.

2. The method of claim **1**, wherein:

the first content object is a webpage having a URL; and

performing the plurality of forward keyword searches comprises performing forward keyword searches until the URL appears in the search results of the forward keyword search.

3. The method of claim **1**, further comprising:

determining that the first content object is absent from a reverse search database that records relationships between content objects and keyword phrases; and

subsequently adding, based on the reverse keyword search, the first keyword phrase to the reverse search database in connection with the first content object.

4. The method of claim **3**, further comprising:

identifying a first identifier of the first content object; and

wherein determining that the first content object is absent from the reverse search database comprises determining that the first identifier is not indexed in the reverse search database.

5. The method of claim 1, wherein the social networking system identifies that the first user interacts with the first content object outside of the social networking system at the previous time period.

6. The method of claim 1, further comprising:

identifying, by the social networking system, a second content object with which the second user of the social networking system has interacted;

conducting a second reverse keyword search on the second content object; and

associating, by the social networking system, the second keyword phrase with the second user.

7. The method of claim 1, further comprising identifying the second keyword phrase associated with the second user from a social networking profile of the second user.

8. The method of claim 1, further comprising:

determining that the first content object is absent from a reverse search database that records relationships between content objects and keyword phrases; and

updating the reverse search database to add an entry for the first content object that associates the first content object with the first keyword phrase from the forward keyword search.

9. A non-transitory computer-readable medium storing instructions that, when executed by at least one processor, cause a computer system to:

identify a first content object with which a first user of a social networking system has interacted at a previous time period;

conduct a reverse keyword search on the first content object to identify a first keyword phrase associated with the first content object by:

performing a plurality of forward keyword searches until the first content object is identified in search results of a forward keyword search of the plurality of forward keyword searches; and

generating the first keyword phrase for the first content object utilizing a keyword phrase of the forward keyword search that identified the search results having the first content object;

associate the first keyword phrase with the first user;

identify a match between the first keyword phrase associated with the first user and a second keyword phrase associated with a second user of the social networking system; and

determine, based on the match, a common interest for the first user and the second user that is represented by the first keyword phrase and the second keyword phrase.

10. The non-transitory computer-readable medium of claim 9, further comprising instructions that, when executed by the at least one processor, cause the computer system to:

determine that the first content object is absent from a reverse search database that records relationships between content objects and keyword phrases; and

update the reverse search database to add a first database entry for the first content object that associates the first content object with the first keyword phrase from the forward keyword search.

11. The non-transitory computer-readable medium of claim 10, further comprising instructions that, when executed by the at least one processor, cause the computer system to conduct the reverse keyword search on a second content object associated with the second user by identifying a second database entry from the reverse search database, wherein the second database entry records a relationship between the second content object and the second keyword phrase.

12. The non-transitory computer-readable medium of claim 10, further comprising instructions that, when executed by the at least one processor, cause the computer system to update a plurality of database entries within the reverse search database with updated keyword phrases by periodically preforming forward keyword searches to identify new associations to content objects.

13. The non-transitory computer-readable medium of claim 10, wherein generating the first keyword phrase for the first content object is based on not identifying an entry in the reverse search database for an identifier associated with the first content object.

14. The non-transitory computer-readable medium of claim 9, further comprising instructions that, when executed by the at least one processor, cause the computer system to provide, within a graphical user interface on a client device associated with the first user, an invitation to associate with the second user.

15. The non-transitory computer-readable medium of claim 9, further comprising instructions that, when executed by the at least one processor, cause the computer system to:

determine that the second user is planning to attend an event associated with the common interest; and

provide, based on the determination, an invitation to the first user to attend the event.

16. A system comprising:

at least one processor; and

at least one non-transitory computer-readable storage medium storing instructions that, when executed by the at least one processor, cause the system to:

identify a first content object with which a first user of a social networking system has interacted at a previous time period;

conduct a reverse keyword search on the first content object to identify a first keyword phrase associated with the first content object by:

performing a plurality of forward keyword searches until the first content object is identified in search results of a forward keyword search of the plurality of forward keyword searches; and

generating the first keyword phrase for the first content object utilizing a keyword phrase of the forward keyword search that identified the search results having the first content object;

associate the first keyword phrase with the first user;

identify a match between the first keyword phrase associated with the first user and a second keyword phrase associated with a second user of the social networking system; and

determine, based on the match, a common interest for the first user and the second user that is represented by the first keyword phrase and the second keyword phrase.

17. The system of claim 16, further comprising instructions that, when executed by the at least one processor, cause the system to:

identify a first entry for the first content object within a reverse search database by utilizing the first content object as input; and

perform an additional forward keyword search to determine an additional keyword phrase for the first content object; and

update the first entry within the reverse search database to associate the additional keyword phrase with the first content object.

18. The system of claim 16, further comprising instructions that, when executed by the at least one processor, cause

the system to identify the match between the first user and the second user based on multiple keyword phrases associated with the first user matching multiple keyword phrases associated with the second user.

19. The system of claim **16**, further comprising instructions that, when executed by the at least one processor, cause the system to:

determine that the first content object is absent from a reverse search database that records relationships between content objects and keyword phrases; and

update the reverse search database to add a first database entry for the first content object that associates the first content object with the first keyword phrase from the forward keyword search.

20. The system of claim **19**, further comprising instructions that, when executed by the at least one processor, cause the system to conduct the reverse keyword search on a second content object associated with the second user by identifying the second keyword phrase within the reverse search database based on the second content object being used as input to the reverse search database.

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